

Replacement Sheets

WATER-ABSORBENT RESIN COMPOSITION AND METHOD FOR PRODUCING
THEREOF, AND ABSORBENT MATERIAL AND ABSORBENT PRODUCT USING
THEREOF

5 BACKGROUND OF THE INVENTION

Field of the Invention:

This invention relates to a water-absorbent resin composition, an absorbent material, and an absorbent product, and a method for the production of the water-absorbent resin composition. More particularly, this invention relates to
10 a water-absorbent resin composition, an absorbent material, and an absorbent product which exhibit excellent hygroscopic and fluid property, separation-resistant property, deodorizing property, gel strength and absorbent property,
15 when used as sanitary materials such as disposable diapers, sanitary napkins, and incontinence pads. This invention further relates to a method for the production of a water-absorbent resin composition possessing such characteristics.

20 Description of the Related Art:

The water-absorbent resin is extensively used in such sanitary materials as disposable diapers, sanitary napkins, and incontinence pads with the object of absorbing such humors as urine and blood and form main components of such sanitary
25 materials as these.

In recent years, in consequence of growth in the demand for adult disposable diapers owing particularly to the aging of the society, the desirability of imparting a deodorizing property, particularly a deodorizing property capable of
30 eliminating offensive odors originating in such sulfur type compounds as hydrogen sulfide and mercaptans, to the water-absorbent resin has been finding growing recognition.

As a means to impart the deodorizing property to the water-absorbent resin, the combinations of the water-absorbent resin with various kinds of deodorants and antibacterial agents have been proposed. For example, a
5 water-absorbent resin composition comprising a water-absorbent resin and the extract of leaves of the trees of theaceous plant (refer to JP-A-S60-158861, for example), an adsorbent resin composition containing the extract of coniferous trees and a water-absorbent resin possessing a
10 specific performance (refer to JP-A-H11-241030, for example), a deodorizing resin composition having zeolite particles dispersed in a water-absorbent resin (refer to U.S. Patent No. 5980879, for example), a water-absorbent resin composition formed of a water-absorbent resin and a
15 metal-containing hydroxide comprising one element selected among titanium and zirconium and at least one element selected among zinc, aluminum, calcium, magnesium, and silicon (refer to JP-A-H10-147724, for example), a water-absorbent resin composition formed of a water-absorbent resin, an oxalate
20 compound, and a complex silicate compound (refer to JP-A-H10-298442), a water-absorbent resin composition formed of a water-absorbent resin, a tannate, and a complex silicate compound (refer to JP-A-H11-116829, for example), a water-absorbent resin composition formed of a water-absorbent
25 resin, a glycine type amphoteric surfactant, and a complex silicate compound (refer to JP-A-H11-49971, for example), and a water-absorbent resin composition formed of a water-absorbent resin, a sulfur-containing reducing agent, and a complex silicate compound (refer to JP-A-H11-148023,
30 for example) have been known.

Methods for imparting a deodorizing property to absorbent products using a water-absorbent resin also have

been **being** studied. For example, an absorbent product formed of refined tea and a water-absorbent resin (refer to JP-A-H2-41155, for example), a disposable diaper containing a water-absorbent resin and a resin formed of benzalkonium chloride and/or chlorohexidine gluconate (refer to 5 JP-A-S63-135501, for example), and a sanitary store combining a water-absorbent resin and zinc aluminosilicate (refer to JP-A-S64-5546, for example) have been known. The feasibility of imparting a deodorizing property and a powder 10 handling property both to a water-absorbent resin also has been **being** studied. For example, an absorbent agent formed of a water-absorbent resin, a compound possessing an antibacterial function against an ammonia-producing microbe, and a pharmaceutical preparation manifesting a neutralizing 15 ability or a neutralizing ability and an adsorbing ability to ammonia (refer to International Publication W000/01479) has been known. As concerns the water-absorbent resin, the improvement in the hygroscopic and fluid property (the improvement in the anti-caking property) forms an important 20 task besides the impartation of a deodorizing property and an anti-bacterial property to the water-absorbent resin. To be specific, the water-absorbent resin has the problem of losing fluidity as powder and entailing the phenomenon of blocking during the course of absorbing humidity. The 25 pamphlet of International Publication W000/01479 also discloses a technique of using various additives for the purpose of solving this problem.

The deodorizing property produced by any of the aforementioned hitherto reported methods is not so great as 30 to reach the level of manifesting a fully satisfactory deodorization in actual use. When the water-absorbent resin sacrifices the absorbent property thereof for the sake of

enabling the deodorizing property thereof to be manifested to a high degree, it does not achieve the inherent object of absorbing such humors as urine and blood.

5 It is, therefore, an important rule to have the absorbent property exalted to a fully satisfactory level while having the deodorizing property manifested to a high degree as well.

When the water-absorbent resin incorporates additives therein for the purpose of enhancing the deodorant property and the hygroscopic and fluid property, it possibly entails
10 such adverse phenomena as separation and exfoliation where the additives are in the form of powder. When the separation or exfoliation of such additives occurs, the additives entail formation of dust and fail to manifest the function thereof fully satisfactorily.

15 SUMMARY OF THE INVENTION

An object of this invention is to provide a water-absorbent resin composition, an absorbent material, and an absorbent product which entail exfoliation of additives from water-absorbent resin only insignificantly, excel in
20 the fluidity of a powder resulting from humidification of a water-absorbent resin or a water-absorbent resin composition, possess a deodorizing property capable of satisfactorily eliminating the offensive odor originating in such sulfur type compounds as hydrogen sulfide and
25 mercaptans, and further excel in the absorptive property. The object of this invention consists in providing a water-absorbent resin composition, an absorbent material, and an absorbent product which have a low ratio of separation of additives, excel in the hygroscopic and fluid property
30 and in the deodorizing property, and also excel in the absorbent property. Another object of this invention is to produce a method for the production of a water-absorbent resin

composition which possesses such characteristics as mentioned above.

The present inventor has pursued a diligent study with a view to solving the task mentioned above. He has consequently taken notice of the fact that the combination of a water-absorbent resin and zinc is effective in manifesting a deodorizing property. He has made a diligent study in search of conditions for enhancing the deodorizing property and enabling the excellent absorbent property and the excellent hygroscopic and fluid property to be manifested fully. He has finally found that the task can be solved by combining a water-absorbent resin possessing a prescribed absorbent property and a complex oxide hydrate containing zinc and silicon or zinc and aluminum at a prescribed ratio.

Specifically, this invention concerns a water-absorbent resin composition having the absorption capacity at 60 minutes toward 0.90 mass% sodium chloride aqueous solution under the pressure of 1.9 kPa not less than 20 g/g, comprising: absorbent resin obtainable by polymerizing an unsaturated monomer having an acid group and/or a salt thereof; and complex oxide hydrate containing zinc and silicon, or zinc and aluminum, wherein the complex oxide hydrate contains zinc as main metal component, and the mass ratio of the content of zinc and the content of silicon or aluminum is in the range of 50/50 - 99/1.

This invention also concerns a water absorbent resin composition further comprising a plant component (C).

Further, this invention concerns an absorbent material for sanitary products comprising the water-absorbent resin compositions mentioned above, and hydrophilic fibers.

This invention further concerns an absorbent material for sanitary product comprising: water-absorbent resin

obtainable by polymerizing an unsaturated monomer containing an acid group and/or a salt thereof, hydrophilic fiber; and complex oxide hydrate containing zinc and silicon, or zinc and aluminum, wherein the complex oxide hydrate contains zinc
5 as main metal component, the mass ratio of the content of zinc and the content of silicon or aluminum is in the range of 50/50 - 99/1, and the water-absorbent resin has the absorption capacity at 60 minutes toward 0.90 mass% sodium chloride aqueous solution under the pressure of 1.9 kPa not
10 less than 20 g/g,

This invention concerns an absorbent product comprising the absorbent material mentioned above, topsheet possessing permeability to liquid; and backsheet possessing impermeability to liquid.

15 This invention also concerns a method for producing water-absorbent resin composition comprising the steps of: polymerizing an unsaturated monomer containing an acid group thereby obtaining a water-absorbent resin having not less than 20 g/g of absorption capacity at 60 minutes toward 0.90
20 mass% sodium chloride aqueous solution under the pressure of 1.9kPa; and mixing the water-absorbent resin and complex oxide hydrate containing zinc and silicon, or zinc and aluminum.

The water-absorbent resin composition, the absorbent
25 material, and the absorbent product of this invention suffer only a low ratio of separation of additives from water-absorbent resin, excel in hygroscopic and fluid property and deodorizing property, and excel also in gel strength and absorbing property. By the method of production
30 according to this invention, the water-absorbent resin composition possessing such characteristics can be obtained.

DETAILED DESCRIPTION OF THE INVENTION

(1) Water-absorbent resin (A)

The term "absorbent resin" (A) as used in this invention refers to a cross-linked polymer which is capable of forming a hydrogel and manifesting water-swelling property and water insolubility. The term "water-swelling property" refers to the ability of the water-absorbent resin in deionized water to absorb the water in a large amount of not less than 5 times, preferably 50 times to 1000 times, its own weight. The term "water insolubility" refers to the fact that the content of the uncross-linked water-soluble component (water-soluble polymer) in the water-absorbent resin (A) is preferably not more than 50 mass% (lower limit: 0 mass%), more preferably not more than 25 mass%, still more preferably not more than 20 mass%, and particularly preferably not more than 15 mass%, and most preferably not more than 10 mass%. Incidentally, the method for determining this water-soluble component is described in Edana Recommended Test Methods 470, 1 - 99 Etractables of European Disposables and Nonwovens Association.

When the content ratio based on the water-absorbent resin in is mentioned in the description of the invention, it is based on the solids content of the water-absorbent resin. It is calculated as the content ratio which is obtained, for example, by drying 1 g of water-absorbent resin for three hours so as to lower the water content thereof to not more than 10 mass%.

As the water-absorbent resin (A) in this invention, the water-absorbent resin which results from polymerizing an unsaturated monomer containing an acid group and/or a salt thereof and possesses a cross-linked structure is used from the viewpoint of deodorizing property and absorbent property.

As the water-absorbent resin (A), one or more compounds

selected from the group consisting of partially neutralized polymer of polyacrylic acid; hydrolyzate of starch-acrylonitrile graft polymer; starch-acrylic acid graft polymer; saponified vinyl acetate-acrylic ester
5 copolymer; hydrolyzate of acrylonitrile copolymer or acrylamide copolymer or cross-linked product thereof; modified carboxyl group-containing cross-linked polyvinyl alcohol; and cross-linked isobutylene-maleic anhydride copolymer may be used. Preferably, as the water-absorbent
10 resin (A), the partially neutralized polymer of polyacrylic acid which is obtained by polymerizing and cross-linking a monomer component having acrylic acid and/or a salt (product of neutralization) thereof as a main component is used.

The water-absorbent resin (A) possesses an acid group
15 and/or a salt thereof. Preferably, the water-absorbent resin (A) is obtained by polymerizing a monomer component having an acid group-containing unsaturated monomer as a main component. The acid group-containing unsaturated monomer includes such a monomer as acrylonitrile which is transformed
20 into an acid group by undergoing hydrolysis subsequent to polymerization. Preferably, the acid group-containing unsaturated monomer which contains the acid group during the course of polymerization is used.

In this invention, the monomer component is preferred
25 to have acrylic acid and/or a salt thereof as a main component.

When the monomer component has acrylic acid and/or a salt thereof as a main component, it may use other monomer in combination therewith. The monomer to be used in this combination does not need to be particularly restricted but
30 is only required to ensure manifestation of the effect of this invention. As concrete examples of the monomer useful for this purpose, such water-soluble or hydrophobic

unsaturated monomers as methacrylic acid, maleic acid, maleic anhydride, fumaric acid, crotonic acid, itaconic acid, vinyl sulfonic acid, 2-(meth)acrylamide-2-methylpropane sulfonic acid, (meth)acryloxyalkane sulfonic acid, and alkali metal salts thereof, and ammonium salts, N-vinyl-2-pyrrolidone, N-vinyl acetamide, (meth)acrylamide, N-isopropyl (meth)acrylamide, N,N-dimethyl(meth)acrylamide, 2-hydroxyethyl(meth)acrylate, methoxypolyethylene glycol (meth)acrylate, polyethylene glycol (meth)acrylate, isobutylene, and lauryl (meth)acrylate may be cited.

When a monomer other than acrylic acid and/or a salt thereof is used, the ratio of the monomer other than acrylic acid and/or the salt thereof is preferably 0 - 30 mol% and more preferably 0 - 10 mol% based on the total amount of the acrylic acid and/or the salt thereof. By using the monomer in this ratio, the performance of absorption of the produced water-absorbent resin is further enhanced. The use of this monomer allows the water-absorbent resin to be obtained more inexpensively. Further, the effect of this invention can be manifested satisfactorily.

The water-absorbent resin (A) possesses a cross-linked structure. The cross-linked structure may be a self-cross-linked type using no cross-linking agent. Preferably, the water-absorbent resin (A) possesses a cross-linked structure which is formed by the copolymerization or reaction using an inner cross-linking agent possessing two or more polymerizing unsaturated groups or two or more reactive groups within the molecular unit.

As concrete examples of the inner cross-linking agent, N,N'-methylenebis(meth)acrylamide, (poly)ethylene glycol di(meth)acrylate, (poly)propylene glycol di(meth)acrylate, trimethylol propane tri(meth)acrylate, glycerin

tri(meth)acrylate, glycerin acrylate, methacrylate, ethylene oxide-modified trimethylol propane tri(meth)acrylate, pentaerythritol hexa(meth)acrylate, triallyl cyanurate, triallyl isocyanurate, triallyl phosphate, triallyl amine, 5 poly(meth)allyloxy alkane, (poly)ethylene glycol diglycidyl ether, glycerol diglycidyl ether, ethylene glycol, polyethylene glycol, propylene glycol, glycerin, pentaerythritol, ethylene diamine, ethylene carbonate, propylene carbonate, polyethylene imine, and glycidyl 10 (meth)acrylate may be cited.

The inner cross-linking agents may be used either singly or in the form of a proper mixture of two or more members. The inner cross-linking agents may be added collectively at once or piecemeal to the reaction system. When the inner 15 cross-linking agent is used, it is favorable to use a compound possessing two or more polymerizing unsaturated group during polymerization for the purpose of enabling the effect of this invention to be fully manifested.

The amount of the inner cross-linking agent to be used 20 is preferably in the range of 0.001 - 2 mol%, more preferably 0.005 - 0.5 mol%, still more preferably 0.01 - 0.2 mol%, and particularly preferably 0.03 - 0.15 mol% based on the amount of the monomer component excluding the cross-linking agent. If the amount of the inner cross-linking agent to be used 25 falls short of 0.001 mol% or exceeds 2 mol%, the deviation from the limits may possibly prevent the produced water-absorbent resin from manifesting the absorbent property fully satisfactorily. It may also possibly prevent the effect of this invention from being fully manifested.

30 The introduction of the cross-linked structure into the polymer by the use of the inner cross-linking agent may be accomplished by adding the inner cross-linking agent to the

reaction system before, during, or after the polymerization of the monomer component or after the neutralization thereof.

Though neutralizing ratio of the water-absorbent resin (A) used in the present invention is not particularly
5 restricted, the neutralizing ratio is preferably 30 - 90 mol %, more preferably 30 - 75 mol %, still more preferably 30 - 70 mol %, most preferably not less than 50 mol % and less than 70 mol % for the sake of enabling the effect of this invention to be satisfactorily manifested.

10 As means to polymerize the monomer component for the purpose of obtaining the water-absorbent resin (A), aqueous solution polymerization, reversed-phase suspended polymerization, bulk polymerization, and precipitation polymerization, for example, are available. From the
15 viewpoint of such factors as the performance, the ease of control of the polymerization, and the absorbent property of the swelled gel, the aqueous solution polymerization or the reversed-phase suspended polymerization performed in an aqueous solution containing the monomer component proves
20 advantageous.

The concentration of the monomer component in the aqueous solution containing the monomer component (hereinafter occasionally referred to as "aqueous monomer solution") is not particularly restricted but may be decided by the
25 temperature of the aqueous solution and the kind of the monomer component. The concentration of the monomer component is preferably in the range of 10 - 70 mass% and more preferably 20 - 60 mass%. When the aqueous solution polymerization is performed, a solvent other than water may be additionally
30 used as occasion demands. The kind of solvent which is so used additionally is not particularly restricted.

The reversed-phase suspension polymerization is a method

of polymerization which requires the aqueous monomer solution to be suspended in a hydrophobic organic solvent. The reversed-phase suspended polymerization is disclosed, for example, in U.S. Patent No. 4093776, U.S. Patent No. 4367323, 5 U.S. Patent No. 4446261, U.S. Patent No. 4683274, and U.S. Patent No. 5244735. The aqueous solution polymerization is a method of polymerizing the aqueous monomer solution without using a dispersing solvent. The aqueous solution polymerization is disclosed, for example, in such U.S. patents 10 as U.S. Patent 4625001, U.S. Patent No. 4873299, U.S. Patent No. 4286082, U.S. Patent No. 4973632, U.S. Patent No. 4985518, U.S. Patent No. 5124416, U.S. Patent No. 5250640, U.S. Patent No. 5264495, U.S. Patent No. 5145906, and U.S. Patent No. 5380808 and such European patents as European Patent No. 15 0811636, European Patent No. 0955086, and European Patent No. 0922717. The monomer components and the initiating agents which are cited in these methods of polymerization may be adopted for the present invention.

In initiating the polymerization, such radical 20 polymerization initiators as potassium persulfate, ammonium persulfate, sodium persulfate, t-butyl hydroperoxide, hydrogen peroxide, and 2,2'-azobis(2-amidinopropane) dihydrochloride; and such photopolymerization initiators as 2-hydroxy-2-methyl-1-phenyl-propan-1-one may be used. The 25 amount of the polymerization initiator to be used is preferably in the range of 0.001 - 2 mol%, and more preferably 0.01 - 0.1 mol% based on the total monomer component in consideration of physical properties of the produced water-absorbent resin.

By performing the polymerization, generally a hydrogel 30 type cross-linked polymer is obtained. This hydrogel type cross-linked polymer is optionally divided finely, and dried, then preferably pulverized before and/or after the drying

to obtain the water-absorbent resin.

The drying is effected at a temperature preferably in the range of 60°C - 250°C, more preferably 100°C - 220°C, and still more preferably 120°C - 200°C. The drying time is
5 selected, depending on the surface area and the water content of the polymer and the kind of the drying device, so as to control a target water content of the water-absorbent resin.

The water content of the water-absorbent resin (A) is not particularly restricted. For the purpose of ensuring the
10 effect of this invention to be manifested satisfactorily, the water-absorbent resin (A) is preferred to be in the form of a powder capable of manifesting fluidity even at room temperature. The water content of the water-absorbent resin (A) is preferably 0.2 - 30 mass%, more preferably 0.3 - 15
15 mass%, and still more preferably 0.5 - 10 mass%. The water-absorbent resin (A) is preferably in the form of powder. The water content of the water-absorbent resin is determined as the amount of water contained in the water-absorbent resin. It is determined, for example, as the amount of loss to be
20 found by drying 1 g of a given water-absorbent resin at 180°C for three hours.

Since it is difficult to decrease to zero the water content of the water-absorbent resin, it is permissible to use the water-absorbent resin in the form of powder which contains
25 a small amount of water on the order of 0.5 - 10 mass%. When the properties specified in the present specification are determined with respect to the water-absorbent resin and the water-absorbent resin composition which are commercially available or the water-absorbent resin and the
30 water-absorbent resin composition which are actually used in disposable diapers, they are determined after a given sample has been dried till the water content decreases to not more

than 10 mass% or it is preferably adjusted to 5 ± 2 mass%. The drying conditions for the sake of adjusting the water content do not need to be particularly restricted but are only required to avoid inducing the water-absorbent resin
5 or the water-absorbent resin composition to sustain any decomposition or denaturation. Preferably, the drying may be performed under reduced pressure at the temperature of not more than 70 °C.

The particulate shape of the water-absorbent resin (A)
10 is not particularly restricted. The particulates of the water-absorbent resin (A) may assume the shape of spheres, crushed fragments, or amorphous grains, for example. The water-absorbent resin is preferred to be in the shape of amorphously crushed grains which are obtained through the
15 pulverizing step. The bulk density of the water-absorbent resin (A) specified in JIS (Japanese Industrial Standard) K-3362, for the sake of enabling the effect of this invention to be satisfactorily manifested, is preferably in the range of 0.50 - 0.75 g/ml, and more preferably 0.60 - 0.73 g/ml.

20 The water-absorbent resin (A) which can be used in this invention is preferred to have further undergone a surface cross-linking (secondary cross-linking) treatment.

Various cross-linking (surface cross-linking) agents are available for the purpose of performing the surface
25 cross-linking treatment and do not need to be particularly restricted. From the viewpoint of enhancing the properties of the produced water-absorbent resin, polyhydric alcohol compounds; epoxy compounds; polyamine compounds; and condensates thereof with haloepoxy compounds; oxazoline
30 compounds; mono-, di-, and poly-oxazolidinone compounds; polyvalent metal salts; and alkylene carbonate compounds are advantageously used.

Though the surface cross-linking agent to be used does not need to be particularly restricted, such surface cross-linking agents as cited in U.S. Patent No. 6228930, U.S. Patent No. 6071976, and U.S. Patent No. 6254990 are available. As concrete examples of the surface cross-linking agent, polyhydric alcohol compounds such as mono-, di-, tri-, tetra- or polyethylene glycol, monopropylene glycol, 1,3-propane diol, dipropylene glycol, 2,3,4-trimethyl-1,3-pentane diol, polypropylene glycol, glycerin, polyglycerin, 2-butene-1,4-diol, 1,4-butane diol, 1,3-butane diol, 1,5-pentane diol, 1,6-hexane diol, and 1,2-cyclohexane dimethanol; epoxy compounds such as ethylene glycol diglycidyl ether and glycidol; polyamine compounds such as ethylene diamine, diethylene triamine, triethylene tetramine, tetraethylene pentamine, pentaethylene hexamine, polyethylene imine, and polyamide polyamine; haloepoxy compounds such as epichlorohydrin, epibromohydrin, and α -methylepichlorohydrin; condensates of the polyamine compounds mentioned above and the haloepoxy compounds mentioned above; oxazolidinone compounds such as 2-oxazolidinone; and alkylene carbonate compounds such as ethylene carbonate may be cited. These surface cross-linking agents may be used either singly or in the form of a mixture of two or more members. For the purpose of ensuring the effect of this invention to be satisfactorily manifested, it is advantageous to use a polyhydric alcohol as the surface cross-linking agent. The polyhydric alcohol is preferred to be on the level of having 2 - 10 carbon atoms, preferably 3 - 8 carbon atoms.

The amount of the surface cross-linking agent to be used is preferably in the range of 0.001 - 10 mass%, and more preferably 0.01 - 5 mass%, based on the amount of the

water-absorbent resin (A), though it is variable with the kinds of compound to be used and the combination thereof.

When the surface cross-linking is performed, it is preferable to use water. The amount of water to be used is preferably in the range of 0.5 - 20 mass%, and more preferably 0.5 - 10 mass%, based on the amount of the water-absorbent resin (A), though it depends on the water content of the water-absorbent resin (A) to be used. It is permissible to use a hydrophilic organic solvent besides water. When a hydrophilic organic solvent is used, the amount thereof is preferably in the range of 0 - 10 mass%, more preferably 0 - 5 mass%, and still more preferably 0 - 3 mass%, based on the amount of the water-absorbent resin (A).

The surface cross-linking is preferably effected by a method which comprises premixing water and/or a hydrophilic organic solvent and a surface cross-linking agent and subsequently causing the resultant aqueous solution to be mixed with the water-absorbent resin by spraying or dropwise addition. A method which resorts to spraying is adopted more preferably. The drops used for the spraying preferably have an average particle diameter in the range of 0.1 - 300 μm and more preferably 0.1 - 200 μm . When water and/or a hydrophilic organic solvent is mixed with the surface cross-linking agent, the mixture may be carried out in the presence of a water-insoluble fine powder or a surfactant on the condition that their existence does not obstruct the effect of this invention.

The water-absorbent resin which has been mixed with the surface cross-linking agent is preferably subjected to a heating treatment. The heating temperature which is determined as the thermal medium temperature or the material temperature is preferably in the range of 100 - 250°C and more

preferably 150 - 250°C. The heating time is preferably in the range of one minute to two hours. A preferred example of the combination of the heating temperature and the heating time is 0.1 - 1.5 hours at 180 °C and 0.1 - 1 hour at 200°C.

5 The preferably surface cross-linking water-absorbent resin which is produced by the procedure described above is preferably adjusted to a specific particle size distribution for the sake of ensuring the effect of this invention to be satisfactorily manifested. The adjustment of the particle
10 size distribution may be performed either before or after the surface treatment. As the means for adjustment of the particle size distribution include, pulverization, classification, and granulation may be cited. It is preferable that these means are controlled to adjust the
15 particle size distribution. Since the water-absorbent resin of this invention possesses such an acid group as carboxyl group and/or a salt thereof, it is capable of effectively neutralizing such a basic odorous substance as ammonia, for example. It appears that the surface area of the
20 water-absorbent resin increases in proportion as the particle diameter decreases and the advantage in neutralizing the basic odorous substance increases in proportion as the surface area increases. It has been found, however, that in the actual use of a gelling agent for urine as in the disposable diaper,
25 the water-absorbent resin as the gelling agent exhibits better results when it is controlled to a specific particle size distribution.

 The mechanism responsible for the manifestation of the effect of adjusting the water-absorbent resin to a specific
30 particle size distribution remains yet to be elucidated. It is inferred, however, that the gel state of the water-absorbent resin has some bearing on the effect in question. It is

inferred that then the particle size distribution is unduly small, the water-absorbent resin induces the phenomenon of gel blocking on account of an unduly high speed of absorption of fluid and the fluid which has entrained an odorous component incurs difficulty in reaching the water-absorbent resin used or the water-absorbent resin composition containing the water-absorbent resin. When the particle size distribution of the water-absorbent resin is unduly large, the odorous component is volatilized from the fluid entraining it on account of an unduly small speed of absorption of the fluid.

To be more specific, the particles measuring not less than 150 μm and less than 850 μm preferably account for 90 mass% (upper limit: 100 mass%) or more of the whole particles and the particles measuring not less than 300 μm account for 60 mass% (upper limit: 100 mass%) or more of the whole particles. Preferably, the particles measuring not less than 150 μm and less than 850 μm is concluded more. Specifically, the particles measuring not less than 150 μm and less than 850 μm account for 95 - 100 mass% and more preferably 98 - 100 mass%. The particles measuring not less than 300 μm preferably account for not less than 65 mass%, more preferably not less than 70 mass%, and particularly preferably not less than 75 mass%. The upper limit for the particles measuring not less than 300 μm is not particularly restricted. Although the value is preferred to be higher, i.e. 100 mass %, the procedure to increase the value up to 100 mass % may possibly cause significant increase of production cost. From this viewpoint, the value may be not more than 99 mass %.

The mass average particle diameter of the water-absorbent resin (A) is preferably in the range of 200 - 700 μm , more preferably 300 - 600 μm , and particularly preferably 400 - 500 μm . The mass average particle diameter

is applied also to the water-absorbent resin composition as described specifically herein below. The mass average particle diameter of the water-absorbent resin (A) or the water-absorbent resin composition may be adjusted, when
5 necessary, by means of granulation.

The absorption capacity with 0.90 mass% of sodium chloride aqueous solution without load is preferably not less than 26 g/g, more preferably not less than 28 g/g, still more preferably not less than 30 g/g, and particularly preferably
10 not less than 32 g/g. If the absorption capacity with 0.90 mass% of sodium chloride aqueous solution without load falls short of 26 g/g, the shortage will possibly result in preventing the effect of this invention from being manifested satisfactorily. Although the absorption capacity without
15 load is preferred to be higher, the procedure to increase the absorption capacity without load more than a value may possibly cause significant increase of production cost and considerable decrease of other properties (e.g. the amount of the water-soluble component). From this viewpoint, the
20 absorption capacity may be not more than 100 g/g, preferably not more than 90 g/g.

The absorption capacity with 0.90 mass% of sodium chloride aqueous solution under load of 1.9 kPa is preferably not less than 20 g/g, more preferably not less than 22 g/g,
25 still more preferably not less than 24 g/g, and particularly preferably not less than 26 g/g. If the absorption capacity with 0.90 mass% of sodium chloride aqueous solution under load of 1.9 kPa falls short of 20 g/g, the shortage will possibly result in preventing the effect of this invention from being
30 manifested satisfactorily. Although the absorption capacity under the pressure is preferred to be higher, the procedure to increase the absorption capacity under the pressure more

than a value may possibly cause significant increase of production cost and considerable decrease of other properties. From this viewpoint, the absorption capacity may be not more than 60 g/g, preferably not more than 50 g/g.

5 For the purpose of enabling the effect of this invention to be manifested to the maximum, it is particularly advantageous to use a water-absorbent resin which has not less than 26 g/g of the absorption capacity with 0.90 mass% of sodium chloride aqueous solution without load and has not
10 less than 20g/g of the absorption capacity with 0.90 mass% of sodium chloride aqueous solution under the pressure of 1.9 kPa.

(2) Complex oxide hydrate (B)

The complex oxide hydrate (B) is a hydrate oxide which
15 contains zinc as a main component based on the total mass of a metal component and contains (b1) zinc and silicon or (b2) zinc and aluminum. The ratio of the zinc element as a main component in the metal component is in the range of 50 - 99.9 mass%, preferably 60 - 95 mass%, and more preferably
20 70 - 95 mass%, based on the total metal component. The term "water-containing oxide," which is otherwise called a hydrated oxide, refers to the hydrate of a metal oxide including the so-called hydroxide. The complex oxide hydrate (B) in the case of (b1) is a water-containing oxide possessing the
25 -Zn-O-Si-bond at least partly relative to zinc (Zn) and silicon (Si) and is different from the mere mixture of a water-containing oxide of Zn and a water-containing oxide of Si. By the same token, in the case of (b2), it is a water-containing oxide possessing the -Zn-O-Al-bond at least
30 partly relative to zinc (Zn) and aluminum (Al) and is different from the mere mixture of water-containing oxide of Zn and water-containing oxide of Al. That is, the complex oxide

hydrate (B) contains (b1) zinc and silicon or (b2) zinc and aluminum. For example, zeolite, the simple mixture of zinc oxide and silicon dioxide, and the simple mixture of zinc oxide and aluminum oxide are not included in the concept of
5 the complex oxide hydrate (B). These compounds are liable to exfoliate from the surface of a water-absorbent resin. They do not lend themselves to the manifestation of the effect of this invention.

When the complex oxide hydrate (B) containing (b1) zinc
10 and silicon or (b2) zinc and aluminum is present in the surface of the water-absorbent resin, the gel which the water-absorbent resin forms by absorbing an aqueous fluid does not easily separate or exfoliate from the surface of the water-absorbent resin. This behavior may be ascribable
15 probably to the fact that the complex oxide hydrate of this invention which contains (b1) zinc and silicon or (b2) zinc and aluminum has a high mass ratio of zinc content in the metal component. In the case of a complex oxide hydrate containing titanium and aluminum or titanium silicon as cited,
20 for example, in a comparative example described specifically herein below, when the water-absorbent resin is gelled by absorbing an aqueous fluid, the gel is easily separated or exfoliated from the surface of the water-absorbent resin. In the actual application of the water-absorbent resin to
25 a disposable diaper, for example, for the sake of heightening the deodorizing effect, the separation or exfoliation of the gel from the surface of the water-absorbent resin is preferred to be as small as permissible.

Further, the complex oxide hydrate (B) which contains
30 (b1) zinc and silicon or (b2) zinc and aluminum is more effective than the simple mixture of the oxides of the relevant metal elements. It is inferred that since the different metals

of zinc and silicon or zinc and aluminum are present in close mutual proximity, the complex oxide hydrate (B) is enabled to repress its separation from the swelled ~~gal~~ gel and exalt the deodorizing effect more effectively than the mere mixture
5 of the oxides of the relevant metal elements. When the water-absorbent resin composition of this invention is obtained by mixing the water-absorbent resin in a powdery form and the complex oxide hydrate in a powdery form, the complex oxide hydrate uniformly adheres to the surface of
10 the water-absorbent resin and represses conspicuously such separation as is observed in the simple mixture.

When the complex oxide hydrate (B) contains (b1) zinc and silicon or (b2) zinc and aluminum at a mass ratio contemplated by this invention as described specifically
15 herein below, it may contain other metal component. From the viewpoint of enhancing the effect further and in terms of the expense, however, the complex oxide hydrate (B) is preferred to be formed solely of the two kinds of metal, i.e. (b1) zinc and silicon or (b2) zinc and aluminum. When the
20 complex oxide hydrate (B) has three or more metal components, the content of the third metal component is preferred to be not more than 5 mass%, more preferably not more than 3 mass%, and still more preferably not more than 1 mass%, based on the total metal components. When zinc is an essential main
25 component in the metal components, the complex oxide hydrate (B) may contain magnesium, calcium, silver, copper, nickel, iron, manganese, titanium, barium, and zirconium.

The mass ratio of the content of zinc and the content of silicon in the complex oxide hydrate (B) containing (b1)
30 zinc and silicon is preferred to be in the range of 50/50 - 99/1, more preferably 60/40 - 99/1, still more preferably 65/35 - 95/5, and particularly preferably 70/30 - 95/5. If